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PARALLEL PDE ALGORITHMS AND SUPERCOMPUTER ARCHITECTURE
(U) PURDUE UNIV LAFAYETTE IN DEPT OF COMPUTER SCIENCES
J R RICE 1985 AFOSR-TR-87-1192 \$AFOSR-84-0385

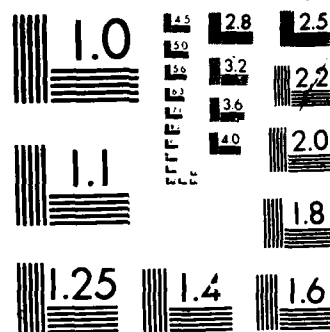
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INFORMAL TECHNICAL REPORT AND PROGRESS REPORT

AFOSR Grant 84-0385

Parallel PDE Algorithms and Supercomputer Architecture

John R. Rice

AFOSR-TR- 87 - 1192

SUMMARY

This report covers activities of John R. Rice (PI) and associates since October 1984. The activity of Kai Hwang (PI) is reported separately because it is being proposed that this grant be separated into two parts due to Kai Hwang's change of position to the University of Southern California. The activities include (1) The completion and submission for publication of one technical paper on expert systems for PDEs, (2) The completion of one report on high level parallel languages for multiprocessors, (3) One manuscript to be presented at a conference in October 1985, (4) Three manuscripts in progress on the use of supercomputers, the use of distributed multiprocessor systems for PDEs and new numerical methods, (5) Considerable progress in the analysis and high level restructuring of several important PDE algorithms for parallel execution. Independently of this grant, the investigators have just obtained a multiprocessor machine (the FLEX 32) which will greatly enhance the research program. <—

1. PERSONNEL.

Work on this grant has involved the following people

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|--------------------|-------------------------------------|
| John R. Rice* (PI) | Professor of Computer Science |
| Elias N. Houstis* | Professor of Computer Science |
| Wayne R. Dyksen | Asst. Professor of Computer Science |
| Calvin Ribbens* | Ph.D. candidate |
| Mehesh Rathi* | Ph.D. candidate |
| Ajay Gupta | Graduate assistant |
| Daniel Wetklow | Graduate assistant |

Those names with stars have received some direct AFOSR support, the others either have no direct research support or have research support from related projects. It is anticipated that all these people will continue to be involved in this work except Gupta and Wetklow. Another graduate student, John Bonomo, is expected to join the project this summer.

2. PAPERS AND PROJECTS.

We list the papers, manuscripts and projects supported by this grant along with a brief description and status report. Consider additional material on these items is attached.

1. *W.R. Dyksen, E.N. Houstis and J.R. Rice, An expert system for partial differential equations.*

This paper describes the design of expert systems to both enhance the user interface for solving PDEs and to distribute these computations in a multiprocessor environment. This paper has been submitted for publication.



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2. *C.E. Houstis, E.N. Houstis and J.R. Rice, Performance evaluation models for distributed computing*

This paper describes the new algorithms developed for allocating PDE computations onto multiprocessor systems. The paper is accepted for presentation at the SIAM Conference on Parallel Processing in October 1985. The current partial manuscript will be supplemented by actual performance data before the conference and before submission to a technical journal.

3. *W.R. Dyksen, E.N. Houstis and J.R. Rice, The Distributed Elliptic-Expert System.*

This partially completed manuscript describes a complete system for the solution of PDEs in a modern supercomputer environment. Its principal components are (1) A very high level language for the user interface, (2) An expert system to help select algorithms for solving PDEs, (3) A knowledge base and knowledge acquisition system for the performance of PDE software, (4) Libraries of PDE solving modules targeted for various architectures (sequential, vector, multiprocessors), (5) An expert system to select the machine to solve the PDE and (6) Heuristic algorithms to map the PDE computation onto the selected machine's architecture.

4. *J.R. Rice, The present and future use of supercomputers.*

This paper has been presented at a recent Army conference and will be presented again in September at another conference. The paper will appear in the proceedings of the Army conference. It describes the languages and workstations appropriate for using supercomputers; its main conclusion is that dramatically improved storage capacities and communication bandwidths are needed to make effective use of future supercomputers.

5. *J.R. Rice, Problems to test parallel and vector languages, CSD-TR 516, May 15, 1985 (95 pages).*

This report presents 16 model problems expressed in four languages. These problems are chosen to test the suitability of various language features to express vector and parallel computations. Data is also presented on the performance of sequential versus vectorized algorithms on the Cyber 205.

6. Considerable progress has been made in analyzing the intrinsic high level parallelism of several important PDE algorithms. This is a key step in the effective use of multiprocessor architectures for PDEs. The algorithms analyzed so far include both finite difference and finite element methods. No manuscript yet exists for this work. It has been performed by John Rice and graduate students.
7. Purdue obtained a Flex 32 multiprocessor in May 1985. This machine initially has 3 processors; it will have 6 in July and be upgraded further later. Each processor has the power of a VAX 750+ (it uses a NS32032 chip) and a megabyte of memory; there are additional memory modules in the machine. The machine's construction allow one to use it in almost any processor/memory configuration. We expect it to be a key element in the research program of this grant.

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